

**INITIAL BRAINSTORMING SESSION**  
**on**  
**Science Topics for Arctic Expedition**

Passive acoustics

Interactions between shelf and basin

Under ice nekton

Water column ecology, incl. Gelatinous zooplankton

Tracer survey in Canada Basin

In-ice community

Deepwater dynamics

Terrestrial carbon fluxes and source/sink on shelf

Hydrothermal venting, e.g., Gakkel Ridge

Observatory on mid-ocean ridge, use of new European icebreaker in 2006?

Ocean fronts, Chukchi and Beaufort

History of climate

Gas hydrates and associated biota

Acquire international data

Biological diversity, conjunction with Census of Marine Life, compare with Antarctic

Mercury fluxes

Sedimentation rates in Canada Basin

Tracking contaminants in all media

Bioaccumulation of contaminants

Continental slope exploration

Fluxes and property transport – current measurements

Ecological processes in winter and fall

Ice edge ecology as it advances and retreats

State of sea ice cover

Solar radiation and ice relationships

Trial deployment of new observing instruments

Fresh water balance

Polynyas

Ice-dependent mammals

Go to highest possible latitude for biota survey

Surface ocean-lower atmosphere exchange, relative to ice cover

Flux and fate of terrestrial organic carbon in benthic boundary layer

Ground truth for airborne survey

Tectonic history of Chukchi Sea and Canada Basin

Benthic ecology

Sub-mesoscale vortices

Atmospheric circulation variability and relation to ice

Focus on ocean, not climate

Biota distribution relative to fronts

Seasonal shifts of biota

Interfaces, interactions, exchanges

Publicly valued exploration

Bioproducts

Coordinate with existing projects, helps define the where/when

Arctic archeology, explore sunken whaling fleet

Emphasize surveys

Past Arctic shelf disasters, erosion etc

Use of GIS as planning tool, incorporate existing data

Concentrate on Basin and link to SBI program

Discriminate OE from NSF program

Pathfinding studies, i.e., trans-Arctic section

Arctic coastal dynamics

Circulation on Canada/Makarov Basins, surface layer (need 30 days for transect into Canada Basin)

Deploy autonomous data loggers

High-resolution bathymetry

Underway measurements as well as fixed stations

Northeastern Bering Sea canyons

Video archive for outreach

Real-time Internet from ship, for K-12 use

Professional media/educator berths, solicit proposals from media organizations (keep this in perspective though)

Seek collaboration with NASA

Provide info to Alaskan villages

Consider Native participation on cruise

Seek specific “targets”

Side-scan sonar

SAR coverage of ship track

Validation of icesat and other satellite data

Heat flow measurements

Coring/sampling of sediments

Identify offshore permafrost areas

2-ship operations in deeper basins for geophysics

## ORGANIZED BRAIN STORMING TOPICS

- A. ecology/diversity/complexity
  - 1. in and under ice, ice edge
  - 2. water column
  - 3. on the slope
  - 4. benthic
  - 5. at fronts
  - 6. microbial to mammals
  - 7. seasonal variability
  - 8. passive acoustics
  - 9. video documentation
  - 10. at gas hydrates, vents, in canyons
  - 11. bioproducts
- B. fluxes/fate
  - 1. carbon
  - 2. mercury
  - 3. shelf-slope-basin
  - 4. fresh water
  - 5. role of ice
  - 6. gas hydrates
  - 7. solar radiation
- C. Canada Basin/Beaufort Gyre
  - 1. sedimentation rates
  - 2. deep water dynamics
  - 3. sub-mesoscale vortices
  - 4. high resolution bathymetry
  - 5. hydrographic tracers
  - 6. state of ice cover
- D. contaminants
  - 1. all media
  - 2. bioaccumulation
- E. N. Eastern Bering/Arctic Canyons
  - 1. survey along length for biota, other features
  - 2. sunken whaling fleet
  - 3. fluxes/transport
  - 4. bioproducts
- F. Paleo/Archeology
  - 1. tectonic history
  - 2. contaminants history
  - 3. sunken whaling fleet
  - 4. past coastal erosion
  - 5. ice scour history
  - 6. glaciation history
- G. Hydrothermal
  - 1. explore for vents
  - 2. vent biota

- H. Outreach
  - 1. topography as it relates to circulation and biota distribution
  - 2. gradients along tracks and at end points
  - 3. links to other programs
  - 4. pose and answer exciting science/human interest questions
- I. Post cruise activities
  - 1. data management
  - 2. information synthesis
  - 3. individual/collaborative publications
  - 4. collected database, distribution

## **REFINED TARGETS FOR SCIENCE PROPOSALS**

- 1. Canada Basin (probably require a 2-ship operation, one a powerful icebreaker)
- 2. Bering and Arctic Canyons (e.g. Barrow Canyon, and extending east to Mackenzie River area and/or west to Chukchi Borderland area)
- 3. Ice edge/Marginal Ice Zone
- 4. Regions of high biological productivity, including ocean fronts (including carbon balance and other tracers)
- 5. Re-occupy SCICEX tracks and fill-in missing data, including sea floor data
- 6. Sunken whaling fleet
- 7. Possible gas hydrate formations (an underway activity?)

## **DATA MANAGEMENT**

- 1. Use GIS format
- 2. assemble historical data for target areas
- 3. plot proposed field sites, stations, tracks
- 4. plot final quality controlled data
- 5. distribute final GIS database (CD-ROM)

**SERVICE or CORE MEASUREMENTS** (those needed by several projects)(NOTE: It was recognized that this list is too long and includes activities best left to individual investigators interested in the topic.)

- 1. detailed bathymetry
- 2. CTD casts, nutrients, chlorophyll, D.O., primary production
- 3. ice and snow thickness
- 4. solar radiation, standard meteorological measurements
- 5. % ice cover
- 6. Surface parameters
- 7. pCO<sub>2</sub>, pH
- 8. turbidity
- 9. optical plankton counter
- 10. sediment coring
- 11. dissolved methane, nitrogen
- 12. oxygen isotopes
- 13. SAR and AVHRR data
- 14. barium
- 15. video transects and profiles
- 16. mammal/bird observations
- 17. adequate navigational data, 1 minute update

## **OUTREACH**

1. need “public-grabbing” issues
2. need both public relations and education activities

## **DISCUSSION ON LOGISTIC AND TIMING ISSUES**

### **SHIPS**

1. Healy – reported as not available June 1-Oct. 15, 2002, plans to be in eastern Arctic in 2003
2. Polar Sea – out of action in 2002 for yard work
3. Polar Star – maybe available to some extent in 2002
4. Canadian icebreakers – 2002 schedule not complete, Marty Bergmann is contact, Laurier about \$10K/day
5. Akademik Fedorov – uncertain but unlikely available in 2002
6. Dranitsen – 200 passenger ship, \$20K/day
7. Yamal (nuclear) - \$50K/day
8. Prof. Khromov - \$5K/day plus fuel, ice strengthened, proposed Russian/US activity in August 2002, needs about 90% of support from US
9. Krasin- heavy diesel icebreaker, could be available for escort duty on days actually needed
10. Chinese icebreaker may be in Arctic next year
11. Marai (Japan) will be in Arctic area in Aug/Sept. 2002, in conjunction with Laurier (Canada)

### **ROV's**

1. Scripps ATV – not now in use, former Navy asset now operated by SIO, some uncertainty over its readiness and utility
2. ROPOS – often used by NOAA, has been mated to Martha Black and Laurier, similar to MBARI Ventana, uses common tools, can be available in summer 2002
3. MBARI – no ROV for Arctic use, can be engineering consultant, has AUV that might offer possibilities
4. HBOI – no ROV for Arctic use
5. Norway – has new ROV in Bergen
6. 2-ship strategy, one for opening ice and other work, and one for deploying ROV

### **OTHER TOOLS**

1. MBARI AUV
2. Russian portable sonars and sediment/rock samplers

### **TIMING ISSUES**

1. Canada Basin – Aug. to Sept. best for operational reasons
2. Canyons and near shore – operations possible June through October
3. Northern Bering/Chukchi – operations possible May through September, Aug/Sept is best for ocean fronts
4. Biological considerations are important, but useful biology can be done at any time in these areas
5. Russia may field an ice camp in March 2002 (Igor Semilitov)
6. US Navy may field an ice camp in 2003
7. A 2-vessel operation could cover all three regions (1-3 above) in a quick survey mode
8. A pilot operation (2 weeks on Polar Star) in 2002 could set the stage for a major activity in 2003

## **SUMMARY OF DISCUSSIONS ON HOW PROPOSALS WILL BE SOLICITED**

1. Open call for letters of interest – done
2. workshop to define priority targets and other guidelines – done
3. suggest to Ocean Exploration (OE) office that Arctic targets defined at workshop be described on OE website as suggestions for proposal writers
4. self-forming teams might prepare more comprehensive proposals, individual proposals OK too
5. if desired, planning updates can be emailed to ARO in confidence to brief OE on what is coming
6. formal proposals to OE in response to AO, which is to be released in August. Arctic needs multi-year proposal
7. consider quick action to prepare the GIS database and add existing data in advance of the expedition (does this have merit even if no Arctic expedition is supported?)

## **Geographic Targets for an Arctic Expedition**

### **Near Shore Canyons**

Canyons in the Arctic Ocean are biological hotspots. Human settlement patterns and historical whaling bases near Barrow and on Herschel Island coincide with Barrow and Mackenzie Canyons respectively. These canyons (as well as Herald Canyon to the west) separate shallow productive shelves from less productive deep basins. Previous studies indicate these canyons are major sites of transport and mixing of waters from different sources. These spatial gradients in oceanographic properties offer the best opportunity for new discovery. Examples include discovering a lost whaling fleet; isolating bioproducts from diverse ecosystems (shelf to basin); investigating large groups of whales both in transit (Barrow) and while feeding (Mackenzie); as well as uncovering traditional ecological knowledge. The large potential of new discovery in and near canyons is due to the large spatial gradients at small spatial scales (50 km). These small scales and dynamic environments challenge traditional measurement techniques and sampling approaches, but they offer unique opportunities for in situ sensing systems (e.g., ROV, AUV, acoustics), which are likely to reveal drastically different populations and regimes within a small and compact spatial domain. Current spatial ranges of passive acoustics (5-10 km) and AUV (10-50 km) span most of these canyon areas. Survey work in these canyons will complement the process-oriented studies to be supported by the NSF's Shelf Basin Interaction (SBI) Program, which will have a major field campaign in the summer of 2002.

### **Chukchi Sea, Ocean Fronts and Productivity, and Extreme Geological Events**

Ocean fronts are typically associated with enhanced biological productivity at trophic levels from plankton to fishes. As a consequence, frontal areas attract marine mammals and sea birds. Most fronts are associated with topographic features (shelf break, canyons, banks (e.g., Herald Shoal)). The fronts and associated surface convergence and downwelling profoundly influence particle flux and sedimentation processes, thus playing a key role in benthic ecology, i.e., shaping the spatial distribution and abundance patterns of benthic organisms.

Five key target locations with defined fronts include:

1. immediately north of the Bering Strait, off Kotzebue Sound
2. Barrow Canyon
3. southern flank of Herald Shoal
4. Siberian coastal current
5. Herald Canyon (Valley) east of Wrangell Island

The last two sites are in the Russian EEZ.

The Chukchi margin (borderland, shelf-slope) is a key target for the investigation of extreme ice events and their role on the destabilization of continental slope terrain. Side-looking sonar is an optimal tool to map the evidence for both deepwater glacigenic bedforms and downslope massive landslides and sediment flows into the basin. Resolution of these features will help to resolve the spacing and timing of "possibly catastrophic" slope destabilization in this unexplored region of the Arctic.

If a Russian ship (possibly with heavy icebreaker escort) participates in this exploration, the opportunity will exist to investigate gas hydrates and methane vents located in the western Bering Sea and Chukchi Sea. This project could be conducted during transit of the ship from a Russian port (e.g., Vladivostok) to the Chukchi margin.



## **Canada Basin/Beaufort Gyre**

Due to its permanent cover of thick multi-year ice, the Canada Basin represents one of the most inaccessible, least studied regions of the Arctic Ocean. In addition, the Canada Basin is one of the most isolated abyssal plains on the world's oceans, with the only deep connection between the world ocean and the Canada Basin being through the Fram Strait. The Lomonosov Ridge restricts most deep water from entering the Canada Basin, increasing the possibility that unique species of deep water and benthic animals may exist in the Canada Basin. Exploratory research in this region will provide opportunities to determine marine biodiversity from microbes to mammals, to map geophysical features (e.g., plate boundaries, gas hydrate deposits, hydrothermal vents, sediment and contaminant deposition rates), and to resolve hydrographic structure and circulation patterns. Strategies for exploring this region could involve the use of submersible remotely operated vehicles (ROVs), autonomous underwater vehicles (AUVs), and deployment of in-ice and under-ice moorings, drifting buoys, time-lapse cameras, traps, net-tows, and traditional oceanographic samplers. Surveys are required to address the fundamental gaps in our knowledge of the diversity and distribution of all communities. Previous investigations indicate that ringed seals, beluga whales, and polar bears may occur throughout the basin. Under-ice fishes and cephalopod fauna that would support these mammals have rarely been sampled. Mass occurrences of both herbivorous and predatory gelatinous zooplankton are known to occur under the permanent ice cap and must influence this fish production. Even the basic production of the protists, upon which the zooplankton feed, is unknown. In-ice, epontic, and benthic communities are similarly unexamined. Novel communities of organisms that should be associated with geological features such as cold-seeps, hydrothermal vents and gas hydrate deposits await discovery. Species distributions, movements of ice and pollutants, transfer of heat and fresh water, and biogeochemical cycling are all affected by water circulation. The direction and magnitude of transport of the arctic gyres, however, are poorly resolved. Little is known about major features such as the Beaufort Gyre, which occurs below the ocean's surface. Explorations in the Canada Basin will complement ongoing research in the Shelf Basin Interaction (SBI) Program of the National Science Foundation, as well as other upcoming international efforts, to yield a broader understanding of the Arctic Ocean.

**ATTENDEES AT NOAA WORKSHOP ON ARCTIC  
EXPLORATION**

**HCHB, Room 6800, July 25-26, 2001**

<b>Name</b>	<b>Institution</b>
Baskaran, Mark	Wayne State U.
Belkin, Igor	U. Rhode Island
Bengtson, John	NOAA/NMFS
Calder, John	NOAA/Arctic Research Office
Cherkashov, Georgiy	VNIIOkeangeologia, Russia
Clough, Lisa	East Carolina U.
Crane, Kathy	Hunter College
Decker, Cynthia	CORE/CoML
Gardner, Joan	DOD/NRL
Gast, Rebecca	Woods Hole Oceanographic
Grebmeier, Jackie	U. Tennessee
Gruzinov, Vladimir	Russia State Duma
Guo, Laodong	U. Alaska
Hameedi, Jawed	NOAA/NOS
Hammond, Steve	NOAA/PMEL
Hildebrand, John	Scripps Institution of Oceanography
Hopcroft, Russell	U. Alaska
Johnson, Leonard	U. Alaska
Jones, Peter	Bedford Institute, Canada
Juniper, Kim	U. Quebec, Canada
Ledbetter, Mike	National Science Foundation
Lupton, John	NOAA/PMEL
MacDonald, Ian	Texas A&M U.
Maksym, Ted	NOAA/National Ice Center
McAdoo, Dave	NOAA/NESDIS
Meehan, Rosa	Dept. Interior/Fish Wildlife Service
Muenchow, Andreas	U. Delaware
Murray, Tom	Contractor
Perovich, Donald	DOD/CRREL
Polyak, Leonid	Ohio State U.
Proshutinsky, Andrey	Woods Hole Oceanographic
Pryamikov, Sergey	AARI, Russia
Pyle, Tom	National Science Foundation
Semiletov, Igor	Pacific Ocean. Inst. Russia
Stein, David	NOAA/OAR
Sychev, Yuri	Russian Polar Foundation
Tervalon, Nicole	Monterey Bay Aq.
Tikku, Anahita	Columbia U.
Trefry, John	Florida Inst. Of Technology
Vecchione, Michael	Smithsonian Institution
Whitledge, Terry	U. Alaska
Yager, Patricia	U. Georgia
Yarincik, Kristin	CORE/CoML
Youngbluth, Marsh	Harbor Branch Oceanographic

